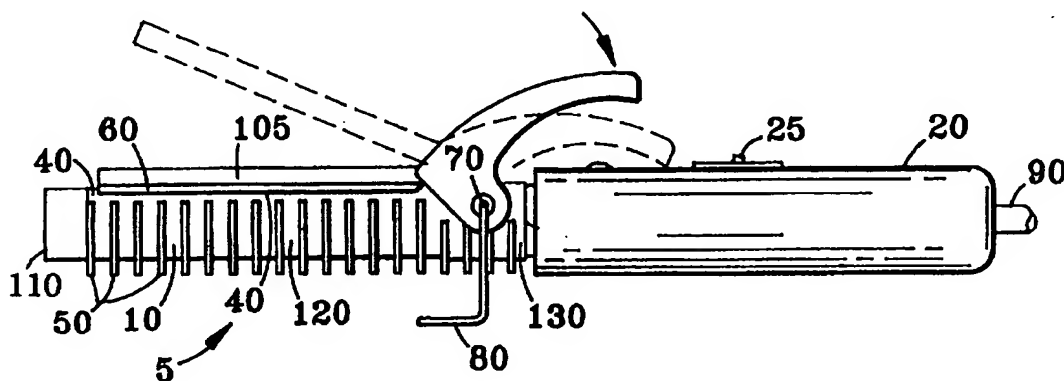


**PCT**WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>A45D 1/04</b>	<b>A1</b>	(11) International Publication Number: <b>WO 98/07345</b> (43) International Publication Date: 26 February 1998 (26.02.98)
(21) International Application Number: <b>PCT/US96/13273</b> (22) International Filing Date: 16 August 1996 (16.08.96) (71)(72) Applicant and Inventor: <b>MONTY, Lawrence, P.</b> [US/US]; 193 Cooper Road, Milton, VT 05468 (US). (74) Agent: <b>TOUW, Theodore, R.</b> ; 4 Forest Lane, Westford, VT 05494 (US).	(81) Designated States: CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  Published <i>With international search report.</i>	

(54) Title: THERMOCHROMIC HANDHELD HAIR CURLING IRON



## (57) Abstract

A handheld personal grooming apparatus (5) for curling or styling hair, has a handle (20), a mandrel or barrel (10) for winding hair (the barrel enclosing a heating element), and a clamp (60) for releasably holding hair against the barrel during curling. The barrel may have styling clips (210) or other styling elements (215) protruding radially outward. The apparatus is characterized in that the barrel, hair clamp, and/or styling elements are coated with a reversibly thermochromic coating (65) or molded plastic overlay (105) to indicate by its color change a temperature range at the barrel surface suitable for rapid curling of hair, preferably 120 °C - 140 °C. A thermochromic coating specially adapted for use on curling irons preferably has three layers: a base layer (150) of a first color, a thermochromic layer (160) (at least one of whose hot and cold colors differs from the first color), and a clear protective layer (170).

BEST AVAILABLE COPY

**THIS PAGE BLANK (USPTO)**

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## DESCRIPTION

### THERMOCHROMIC HAND-HELD HAIR CURLING IRON

#### TECHNICAL FIELD

5 This invention relates generally to personal care appliances and particularly to hand-held hair curling irons having a reversibly thermochromic coating or overlay for indicating the operating temperature of the barrel or mandrel by a color change.

#### BACKGROUND ART

10 Electrically powered hand held curling irons have been in use for years for curling and/or styling hair using heat, dry or wet, combined with pressure and/or stroking/drawing action. U.S. Pat. No. 4,215,264 provides a telescoping hair curler with a heatable barrel and a clamp activated by an intermediate pivoting element. U.S. Pat. No. 4,292,986 describes a heated styling brush consisting of a handle, a heating element and an open - ended tube having a number of rows of radially projecting teeth extending from its outer surface. U.S. Pat. No. 5,212,366, discloses an electrically powered hand held curling appliance inclusive of  
15 a perforated barrel for delivering warm air to the hair

Particular hair curlers are available on the market with a "ready dot," a dot of reversibly thermochromic coating paint on the top end of each curler, which changes color from red to black at 65 °C to 75 °C when the curler is heated for hair curling. This reversibly thermochromic paint dot may contain a cuprous mercuric iodide complex as disclosed by  
20 Pedersen in U.S. Pat. No. 3,665,938.

"Ready dots," as often used on the end of curlers in the past, are inadequate for appraising the heating of extended areas as in the case of whole barrels or mandrels of curling or styling irons. Since these appliances have an extended working surfaces, it is important to know that all or a major portion of their surfaces have reached the proper  
25 operating temperature.

The prior art has not recognized the importance of giving to the user of a hair curling iron a clear indication of the temperature at the surface that is directly effective for curling or styling of the hair. In addition, up to now the user has had no indication of the temperature reached by the curling or styling iron during the warm-up period and no indication that the  
30 whole area of the curling or styling surface has reached the optimum temperature.

### Purposes, Objects, and Advantages of the Invention

5 A major purpose of this invention is providing the user of a hair curling or hair styling iron with a clear indication of the temperature at the surface that is effective for curling or styling of the hair. Subsidiary purposes include providing the user with a qualitative indication of the temperature reached by the curling or styling iron during the warm-up period, and providing the user with an indication that the whole of the curling or styling surface has reached the optimum temperature.

10 An object of this invention is to provide a hair care appliance which indicates to the user at a glance that the curling iron's barrel or mandrel has reached a temperature suitable for curling hair. A particular object is a hair curling appliance that indicates such a suitable temperature within a relatively narrow range that is especially effective for curling hair in a short time. A related object is a curling iron which provides the user with a visual indication that the effective surface of the curling iron has reached the desired operating temperature of  
15 120 - 140 degrees Celsius. Another object is a hair curling iron whose temperature indication is localized at the specific surface around which the hair is curled. Another object is a thermochromic coating that is readily adaptable to various uses. Yet another object is a thermochromic coating that does not readily yellow or otherwise change its color undesirably from exposure to excessive heat or from exposure to ambient light. Important objects are a  
20 thermochromic coating and a thermochromic hair curling iron which do not contain toxic substances such as mercury compounds, which might contaminate the environment when ultimately discarded. Another object is a hair curling iron having a substantially cylindrical reversibly thermochromic barrel or mandrel surface which also has a surface texture, surface hardness, and heat capacity especially suitable for curling of hair. Other objects include an  
25 appliance that visually displays the location of areas too hot to handle comfortably, and an appliance that indicates when it has cooled enough to be safely handled and stored away. A practical object is an efficient and economical process for manufacturing a reversibly thermochromic hair curling iron. Finally, other objects include thermochromic hair curling  
30 irons that combine visually attractive colors and textures with improved function to provide commercially more valuable personal care products.

These purposes, objects, and advantages and others will become clear from the following description of the invention and the accompanying drawings.

- 3 -

**DISCLOSURE OF THE INVENTION**

A hand-held personal grooming apparatus for curling or styling hair has a handle, a mandrel or barrel for winding hair (the barrel enclosing a heating element), and a clamp for releasably holding hair against the barrel during curling. The barrel may have styling clips or other styling elements protruding radially outward. The apparatus is characterized in that the barrel, hair clamp, the styling clips, and/or other element(s) in thermal contact with the barrel are coated with a reversibly thermochromic coating to indicate by its color change a temperature range at the barrel surface suitable for rapid curling of hair, preferably between 120 °C and 140 °C. A thermochromic coating specially adapted for use on curling irons preferably has three layers: a base layer of a first color, a thermochromic layer (at least one of whose hot and cold colors differs from the first color), and a clear protective layer.

The current invention provides a method and apparatus for the optimum curling or styling of hair in a short time. Our extensive studies have shown that rapid curling or styling of hair will occur in an optimum temperature range between about 120 °C and about 140 °C. This is especially the case for curling with a curling or styling iron, to be used for a few seconds at each application to the hair. This desired temperature range may be contrasted with the lower temperature range that is suitable for slower curling, as with individual hair curlers intended to be left in the hair for at least several minutes.

Hair curling and styling effects are obtainable by using heat and pressure simultaneously on hair curled around heated barrels or mandrels of different diameters, with or without the assistance of mechanical clamps. Additional styling effects are obtainable using comb-like attachments provided with protrusions in contact with a heated barrel so as to be heated by combined conduction and convection to the optimum curling or styling temperature. Our studies have demonstrated that the best curling and styling effects are obtained using a barrel or mandrel heated in the optimum temperature range between 120 °C and 140 °C, combined with mechanical action such as wrapping hair around a heated barrel, with or without clamping pressure, or by drawing hair through comb-like protrusions in a combing or combined wrapping/pull motion.

Reversibly thermochromic coating color changes are displayed once the optimum temperature has been achieved at key surfaces such as the heated barrel in direct contact with hair being curled or styled. It is important that such a temperature be reached and uniformly maintained during the curling or styling process and that the user be advised when the curling iron is hot and ready to use. Because the optimum temperature for rapid curling and/or styling is relatively high, it is desirable to show the user that the optimum temperature has been reached, using a color change on a surface having thermal contact with the barrel surface, such as the mechanical holding clamp and the styling elements.

- 4 -

Thus a number of embodiments of the invention can achieve the purpose of thermochromically indicating the temperature of the barrel in slightly different ways. The most direct way utilizes a reversibly thermochromic coating on the barrel surface itself, changing color at about the lower end of the optimum temperature range for rapid curling, viz. about 120 °C. A disadvantage of this approach is that the thermochromic material should be very resistant to permanent color changes, such as yellowing, at those operating temperatures. Such permanent color changes, if they occur, can lead to relatively short useful life of the coating or can cause user dissatisfaction with the appliance's esthetic appearance. By using the clamp and/or styling elements to indicate the temperature at the barrel surface, thermochromic substances or coatings can be used that exhibit a color change at somewhat lower temperatures, temperatures offset by a predetermined amount below the optimum curling temperature of the barrel surface. If the temperature offset is about 70 - 75 °C, for example, then reversibly thermochromic substances exhibiting color changes at about 45 °C to 70 °C can be used. Thus this approach can still indicate the temperature at the surface that is in direct contact with the hair during curling, but can do so without disadvantages associated with thermochromic substances having color changes at or above 120 °C.

The hand-held curling and styling apparatus of this invention provides for treating the hair for curling or styling using a heated barrel with holding clamp and styling clips all operating at proper temperatures. The temperature is prominently displayed by the color of the whole barrel, or a portion of the barrel, or the clamp, or styling clips, or any combination of these elements. In addition, improper operation of the hand-held curling or styling iron can be detected by a non-uniform heating pattern.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 depicts a side elevation view of a hand-held curling iron made in accordance with the invention.

FIG. 2 depicts a side elevation view of a second embodiment of a hand-held curling iron.

FIG. 2a depicts a cutaway perspective view of a detail of an embodiment of a hand-held curling iron made in accordance with the invention.

FIG. 2b depicts a partial perspective view of another detail of an embodiment of a hand-held curling iron.

FIG. 3 depicts a side elevation view of a third embodiment of a hand-held curling iron.

FIG. 4 depicts a side elevation view of a fourth embodiment of a hand-held curling iron.

**BEST MODE FOR CARRYING OUT THE INVENTION**

A hand-held personal grooming apparatus 5 for curling and/or styling hair made in accordance with the present invention is depicted in a side elevation view in FIG. 1. The hair  
5 curling iron apparatus 5 includes an elongated heat-conducting barrel 10 equipped with a heat-insulated handle 20, preferably provided with an On-Off switch 25. Barrel 10 may have a cylindrical, polygonal, pyramidal, or frustoconical shape.

Barrel 10 preferably has projections 50 to protect the scalp of the user against possible burns during the curling of the hair and to aid in styling. In the embodiment shown  
10 in FIG. 1, the projections 50 are generally semicircular elements of plastic which remain relatively cool when barrel 10 is heated. The remainder of the heat-conducting barrel 10 is left uncovered to provide a surface 40 for curling hair. This portion of heat-conducting barrel 10 is heated and used for curling.

A spring loaded clamp 60 is pivotally connected to the insulated part of the barrel using a pin 70. Pin 70 can be additionally used for holding in place a foldable stirrup 80  
15 which, when unfolded, provides for keeping the hand-held hair curling iron away from a counter top surface or other resting surface while being heated or while hot but not in use. Clamp 60 is used to hold the hair in contact with the heated portion 40 of the heat-conducting barrel 10.

In one preferred embodiment, clamp 60 has an overlay 105 that changes color when it reaches a temperature related to the temperature at the surface of barrel 10. For example,  
20 overlay 105 may be formed of thermochromic blue plastic which changes to white when it reaches a temperature of about 45 °C to 70 °C. Overlay 105 may be molded to the surface of clamp 60, utilizing apertures spaced along the length of clamp 60, with small portions of plastic of overlay 105 extending through and locking into the apertures, as is known in the  
25 manufacturing arts. It is important to provide fairly good thermal contact between thermochromic overlay 105 and clamp 60, but some unavoidable thermal resistance at the interface can be compensated for by choosing a suitable offset between the desired curling temperature at the surface of barrel 10 on the one hand and the thermochromic transition  
30 temperature of overlay 105 on the other. In the example described above, the temperature offset is about 70 - 75 °C, so that overlay 105 changes color at about 45 °C to 70 °C when barrel 10 reaches the desired optimum temperature of about 120 °C to 140 °C for rapid curling of hair.

A power cord 90 is normally used to provide power to conventional internal heaters,  
35 which are contained in this embodiment within the uncovered portion of the heat-conducting



- 6 -

barrel 10. Power cord 90 is preferably made to have a free rotational mode along the connecting axis to eliminate kinks in the cord. The internal heater may consist of two or more heating elements, arranged to heat the distal end 110 of barrel 10 more than its center 120 or its handle end 130 (near handle 20) and to heat its handle end 130 more than its center portion 120, in order to compensate at least partially for greater heat loss from the ends and thus to provide a more uniform temperature along barrel 10. The same temperature uniformity effect may be produced by various arrangements of insulating material, or by various values of electrical resistance and of temperature coefficient of electrical resistance along the length of an integral heater.

Either a visible surface of the clamp 60 or the uncovered part of the heat-conducting barrel 10 (or both) are painted with a reversibly thermochromic coating 65 or overlaid with an overlay layer 105 of reversibly thermochromic plastic. Coating 65 is shown in FIGS. 2, 2a, 3, and 4. The reversibly thermochromic coating or plastic overlay displays a change in color when the appropriate temperature for rapidly curling hair has been reached at the barrel surface 40 where the hair is curled. A process sequence for applying the reversibly thermochromic coating to produce a layered structure is described now with reference to Table I. Table I shows the preferred composition proportions by weight of the components combined to apply each layer of the coating. The completed coating 65 preferably consists of a three layer structure (illustrated in FIG. 2a) including a pigmented base layer 150 covered with a reversibly thermochromic layer 160, which is in turn preferably covered with a transparent protective top coat layer 170.

<u>Component</u>	<u>Base layer</u> <u>150</u>	<u>Thermochromic</u> <u>layer 160</u>	<u>Top layer</u> <u>170</u>
Tinted epoxy resin	100	0	0
Thermochromic epoxy resin	0	100	0
Clear epoxy resin	0	0	100
Epoxy curing agent	40	40	58
Solvent (e.g. xylene)	50	50	50
<b>TOTAL</b>	190	190	208

**TABLE I. Composition proportions of layers of preferred thermochromic coating 65**

- 7 -

The base layer 150 may be a layer of white epoxy paint, for example, which may contain titanium dioxide as the white pigment (e.g about 30% titanium oxide in clear epoxy). If the substrate that is to be covered with the thermochromic coating has a color to provide suitable contrast with the thermochromic layer 160, the base layer may be omitted, but the presence of the white base layer is generally preferred. The basic epoxy substances used in these layers are conventional epoxies (except for the thermochromic property), typically clear viscous pastes having viscosities at 25 °C ranging from about 1000 cps for the clear epoxy resin, and about 3,000 - 4,000 cps for the base layer epoxy with pigment, to about 15,000 - 25,000 cps for the reversibly thermochromic epoxy layer. The unmixed curing agent for the epoxy (also a conventional material) is typically more viscous at 30,000 - 40,000 cps.

A preferred reversibly thermochromic coating has the property of changing from a substantially opaque or translucent color to a substantially transparent condition at a transition temperature that is chosen to indicate the desired barrel temperature. Thermochromicity is provided by a particulate thermochromic substance comprising about 5% to 50%, preferably about 30% of the layer. The particle diameters of the particulate thermochromic substance are preferably less than about 100 micrometers, and more preferably less than or equal to about 20 micrometers. The thermochromic layer may also contain conventional color dyes and pigments if desired. The thermochromic layer may be formed, for instance, by using a Chromicolor™ paint produced by Matsui Shikiso Chemical Co. Ltd. of Japan that has a suitable thermochromic transition temperature. The latter material can be obtained in many colors, such as orange, vermilion, green, blue, turquoise, and others. This type of thermochromic paint loses opacity and becomes transparent upon reaching its specified transition temperature. A clear top coat of transparent epoxy is preferably applied to protect the reversibly thermochromic coating layer from yellowing and for improved heat resistance.

The optimum temperature for the surface of barrel 10, for curling the hair quickly and effectively in a short time, typically about 30 seconds, is about 130 °C plus or minus about 10 °C. Base paint layer 150 and/or the interface between plastic overlay 105 and clamp 60 insulate the reversibly thermochromic layer 160 somewhat from the barrel 10, so the color-change temperature can be somewhat lower than the optimum barrel temperature, as mentioned above. Another way of expressing this temperature offset is that there are thermal resistances at the interfaces between the hair curler's barrel 10 and the clamp 60, and between the clamp material and the thermochromic coating 65 or the overlay 105. With this temperature offset taken into account, the optimum temperatures for the color change (loss of opacity) on the reversibly thermochromic coating or overlay part on the clamp are about 45 °C to about 70 °C.

- 8 -

The coating process consists of four steps, where the setting times given are suitable for the viscosity values described above, and using the proportions shown in Table 1:

1) Cleaning the item(s) or surfaces to be painted with a suitable solvent, such as isopropyl alcohol (IPA).

5        2) Applying the pigmented base layer 150, letting it set (air dry) for 5 minutes for leveling, and then baking at 140 °C for 20 minutes. A suitable thickness is achieved at about 60 g/m<sup>2</sup>.

10       3) Applying the reversibly thermochromic coating layer 160, in the selected color, at a specified thickness, letting it set for 10 minutes, and then baking at 140 °C for 20 minutes. A suitable thickness is achieved at about 120 g/m<sup>2</sup>.

4) Applying the protective transparent top coat layer 170 at the required thickness, letting it set for 10 minutes, and baking at 140 °C for 20 minutes. A suitable thickness is achieved at about 60 g/m<sup>2</sup>.

15       The various layers may be applied with a spray gun, for example. The finished coating 65 consists of a three layer structure 65 where a base layer 150 (preferably of white paint which may contain titanium dioxide as the white pigment) is coated with the reversibly thermochromic layer 160, which is coated in turn with the protective transparent top coat layer 170.

20       FIG. 2 shows a second embodiment of a hand-held hair curler made in accordance with the invention, in its styling configuration, with styling clips 210 or alternative styling elements 215 illustrated in FIG. 2b. The styling clips 210 or 215, each having a reversibly thermochromic coating, are slidably held along longitudinal slots or grooves 220 in the outside surface of barrel 10. Clamp 60 has reversibly thermochromic coating 65, illustrated in more detail in FIG. 2a.

25       A portion of the heat-conducting barrel is left uncovered to provide a surface 40 for curling hair. This portion of the heat-conducting barrel is heated and is provided with longitudinal slots 220 formed along the length of the heat-conducting barrel 10. The construction is depicted in FIG. 2 showing how styling elements 210 are slidably held after being inserted into the longitudinal slots 220. Access to slots 220 is attained by unscrewing an internally threaded retaining cap 230. The styling elements 215 depicted in the FIG. 2b have a formed surface which also may be coated with the reversibly thermochromic coating 65 described hereinabove.

35       Thus either the surface of the styling elements 210 or 215 or a portion of the surface of the heat-conducting barrel 10 or both is coated with a reversibly thermochromic coating 65 which is chosen to exhibit a change in the perceived color with change in temperature.

- 9 -

This color change indicates when the appropriate temperature for rapidly curling hair has been reached at the surface 40 of barrel 10.

5 A third embodiment of the hand-held curling iron is shown in FIG. 3: a hair curler, where either or both barrel and clamp are coated with reversibly thermochromic coating or overlay to display the temperature level and temperature uniformity of barrel 10 and/or clamp 60. This embodiment is shown with a relatively small barrel diameter in comparison with the other embodiments. The coatings used for various sizes of hair curler models may have different colors, either in their unheated state or in their heated state, or both.

10 Another feature is also shown in FIG. 3. This additional feature is a rotating ring control 310 that provides for stepwise-increasing or decreasing the temperature of heat-conducting electrically heated barrel 10. Three positions are marked as "LOOSE", "MEDIUM," and "TIGHT." The rotary ring control 310 used to perform the temperature adjustment may be color coded for easy identification.

15 In all the embodiments disclosed above, a reversibly thermochromic coating 65 or plastic overlay 105 is coated or painted or laminated to the outer surface of clamp 60 or to a visible portion of the heat-conducting heated barrel 10. In the embodiment of FIG. 2, the styling elements 210 or 215 may be formed of reversibly thermochromic plastic.

20 FIG. 4 shows a different embodiment of this invention: the hair curler has a larger diameter barrel 10, covered with flocking material. The curler is provided with a spring loaded clamp 60, coated with reversibly thermochromic coating 65 or layered with reversibly thermochromic plastic overlay 105.

25 In another embodiment (not shown), a reversibly thermochromic coating layered laminate structure is applied to the clamp or other barrel areas. This laminate structure is obtained in a separate fabrication step where the epoxies described above, are sequentially layered and formed in a continuous fabrication process to yield a final reversibly thermochromic three-layered plastic body, which is, after the appropriate steps of cutting and trimming, pressure bonded to clamp 60 and/or barrel 10.

## INDUSTRIAL APPLICABILITY

30 The hair curling or hair styling iron of this invention provides the user with a clear indication of the temperature at the surface that is effective for curling or styling of the hair, provides a qualitative indication of the temperature reached by the curling or styling iron during the warm-up period, and provides an indication of when at least a major portion of the curling or styling surface of the barrel or mandrel has reached the optimum temperature for curling hair. The invention particularly indicates such a suitable temperature within a  
35 relatively narrow range that is especially effective for curling hair in a short time, viz. about

- 10 -

120 °C to 140 °C. The thermochromic coating of the invention is readily adaptable to various other uses, as the coating does not readily yellow or otherwise change its color undesirably from exposure to excessive heat or from exposure to ambient light.

5 Other embodiments of the invention will be apparent to those skilled in the art from a consideration of this specification or from practice of the invention disclosed herein. For example, combinations of thermochromic layers having various colors may be used to produce special color effects. Several other variations are implicitly disclosed in this specification. Various base colors can be selected with different combinations of reversibly thermochromic coatings to offer the best contrast when the hair curler is hot. Conversely, all  
10 the areas could be coated with reversibly thermochromic coating; upon heating, the hot areas would be identified by change(s) in coloration. Colors may be chosen to have psychological connotations considered appropriate to the respective temperature ranges: e.g. "cool" blues or greens contrasting with "warm" yellows, oranges, pinks, or reds.

15 Additional configurations of the hand-held curling or styling iron may have different contrasting base colors for the first epoxy layer, which may additionally be inlaid, overlaid, or scrolled so to carry a message or a design. Such a message or design is invisible to the user as long as the hand-held curling iron is cold, to be revealed only upon the reversibly thermochromic coating's reaching the transition temperature, becoming transparent and showing through to the first layer. The message may display a warning message about the  
20 danger of handling the hot area or may be of an advertising nature, such as a company logo or a personalized identification made on a special order.

The On-Off switch does not have to be wired in parallel with a pilot light since the reversibly thermochromic coating color change will indicate that the hand-held curling iron is in operation. Those familiar with the art will easily recognize other functionally equivalent  
25 configurations, in which, for example color-changing single layers could be used.

It is intended that the specification and examples be considered as exemplary only, with the true scope and spirit of the invention being defined by the following claims.

Having described my invention, I claim:

- 11 -

## CLAIMS

1. A hand-held hair-curling iron having a handle, a barrel for winding hair and said barrel enclosing a heating element, and a clamp for releasably holding hair against said barrel during curling, the hand-held hair-curling iron being characterized in that  
5 at least one of said barrel, said clamp, or an element in thermal contact with said barrel is covered on at least one side with a thermochromic substance to indicate by its color change a temperature suitable for curling hair.
2. A thermochromic coating for indicating that a surface has reached at least a desired temperature, comprising:  
10 (a) a base layer of epoxy paint containing pigment for reflecting light;  
(b) a middle layer of thermochromic epoxy paint characterized by a color change related to said desired temperature, said middle layer being disposed to have at least indirect thermal contact with said surface; and  
(c) a top layer of clear epoxy for protecting said middle layer.
- 15 3. A hand-held hair-curling iron as recited in claim 1, wherein said thermochromic coating comprises:  
(a) a base layer of epoxy paint containing pigment,  
(b) a middle layer of thermochromic epoxy paint characterized by a color change related to said temperature suitable for curling hair, and  
20 (c) a top layer of clear epoxy for protecting said middle layer.
4. A hand-held hair-curling iron as recited in claim 1, wherein said barrel is covered with said thermochromic coating and said color change occurs at about said temperature suitable for curling hair.
5. A hand-held hair-curling iron as recited in claim 1, wherein said clamp has a top surface  
25 facing away from said barrel, and said clamp is covered on at least said top surface with said thermochromic coating.
6. A hand-held hair-curling iron as recited in claim 1, wherein said temperature suitable for curling hair is between about 120 °C and about 140 °C.
7. A hand-held hair-curling iron as recited in claim 1, wherein said temperature suitable for  
30 curling hair is about 130 °C.
8. A hand-held hair-curling iron as recited in claim 1, wherein said color change comprises a transition from a first color at temperatures below said temperature suitable for curling hair to a second color at and above said temperature suitable for curling hair.
9. A hand-held hair-curling iron as recited in claim 1, wherein said color change comprises a  
35 transition from a first color at temperatures below said temperature suitable for curling

- 12 -

hair to a substantially colorless state at and above said temperature suitable for curling hair.

10. A hand-held hair-curling iron as recited in claim 1, wherein said color change comprises a transition from a first color at temperatures below a first temperature to a second color at and above a second temperature, said second temperature differing by a predetermined offset amount from said temperature suitable for curling hair.
11. A thermochromic coating as recited in claim 2 wherein said desired temperature is a temperature suitable for curling hair.
12. A thermochromic coating as recited in claim 2 wherein said desired temperature is between about 120 °C and about 140 °C.
13. A thermochromic coating as recited in claim 2 wherein said desired temperature is about 130 °C.
14. A thermochromic coating as recited in claim 2 wherein said color change comprises a transition from a first color at temperatures below said desired temperature to a substantially colorless state at and above said desired temperature.
15. A thermochromic coating as recited in claim 2 wherein said color change comprises a transition from a first color at temperatures below a first temperature to a second color at and above a second temperature, said second temperature differing by a predetermined offset amount from a temperature suitable for curling hair.
16. A thermochromic coating as recited in claim 2 wherein said base layer of epoxy paint comprises a two-part epoxy containing white pigment.
17. A thermochromic coating as recited in claim 2 wherein said thermochromic layer comprises 100 parts of a two-part epoxy, 10 to 100 parts of a thermochromic particulate material, and 0 to 100 parts of conventional dyes and pigments.
18. A thermochromic coating as recited in claim 2 wherein said clear layer comprises a two-part clear epoxy.
19. A hand-held hair-curling iron as recited in claim 10, wherein said predetermined offset amount is chosen such that hair clamped between said clamp and said barrel is at said temperature suitable for curling hair when said color change occurs.
20. A hand-held hair-curling iron as recited in claim 10, wherein said first temperature is about 45 °C and said second temperature is about 70 °C.
21. A thermochromic coating as recited in claim 15, wherein said first temperature is about 45 °C and said second temperature is about 70 °C.

- 13 -

22. A hand-held hair curling and styling appliance, comprising:
- (a) a handle,
  - (b) a barrel for winding hair, said barrel extending from said handle and having an exterior surface,
  - 5 (c) a heating element enclosed by said barrel, and
  - (d) a clamp for releasably holding hair against said barrel during curling, said clamp being pivotally attached to said handle, said clamp having an outside surface and an inside surface, and said clamp extending along said barrel;
- 10 and the hand-held hair curling and styling appliance being characterized in that at least one of said barrel or said clamp further comprises a thermochromic coating to indicate by its color change a temperature of said barrel suitable for curling hair.
23. A hand-held hair curling and styling appliance as recited in claim 22, wherein said barrel comprises a multiplicity of protrusions for engaging hair.
24. A hand-held hair curling and styling appliance as recited in claim 22, wherein said 15 thermochromic coating covers at least said exterior surface of said barrel.
25. A hand-held hair curling and styling appliance as recited in claim 22, wherein said thermochromic coating covers at least said outside surface of said clamp.
26. A hand-held hair curling and styling appliance as recited in claim 23, wherein said thermochromic coating covers at least said protrusions.
- 20 27. A hand-held hair curling and styling appliance as recited in claim 23, wherein said protrusions are removably fastened to said barrel.
28. A hand-held hair curling and styling appliance as recited in claim 23, wherein said clamp engages said barrel between said protrusions.
29. A hand-held hair curling and styling appliance as recited in claim 25, wherein said 25 exterior surface of said barrel is flocked.
30. A hand-held hair curling and styling appliance as recited in claim 27, wherein said protrusions are removably attached to said barrel.
31. A hand-held hair curling and styling appliance as recited in claim 30, wherein said barrel has a plurality of longitudinal grooves formed in said exterior surface of said barrel, and 30 wherein said protrusions comprise toothed strips slidably engaging said grooves, each of said toothed strips having a multiplicity of teeth extending radially outward from said exterior surface of said barrel.
32. A hand-held hair curling and styling appliance as recited in claim 30, wherein said barrel has a plurality of longitudinal grooves formed in said exterior surface of said barrel, and 35 wherein said protrusions comprise styling elements slidably engaging said grooves, each



- 14 -

of said styling elements having a multiplicity of hairpin-shaped portions extending radially outward from said exterior surface of said barrel.

33. A hand-held hair curling and styling appliance, comprising:

(a) a handle,

5 (b) a barrel for winding hair, said barrel extending from said handle and having an exterior surface,

(c) a multiplicity of protrusions for engaging hair, extending outward from said exterior surface of said barrel,

(c) a heating element enclosed by said barrel, and

10 (d) a clamp for releasably holding hair against said barrel during curling, said clamp being pivotally attached to said handle, said clamp having an outside surface and an inside surface, and said clamp extending longitudinally along said barrel between said multiplicity of protrusions;

15 the hand-held hair curling and styling appliance being characterized in that at least one of said barrel, said protrusions, or said clamp further comprises a thermochromic material to indicate by its color change a temperature suitable for curling hair.

34. A hand-held hair curling and styling appliance as recited in claim 33, wherein said clamp further comprises:

20 (a) an inner portion forming said inside surface of said clamp and conforming generally to said exterior surface of said barrel, and

(b) an outer portion fastened to said inner portion said outer portion forming said outside surface of said clamp, and said outer portion comprising said thermochromic material.

1/2

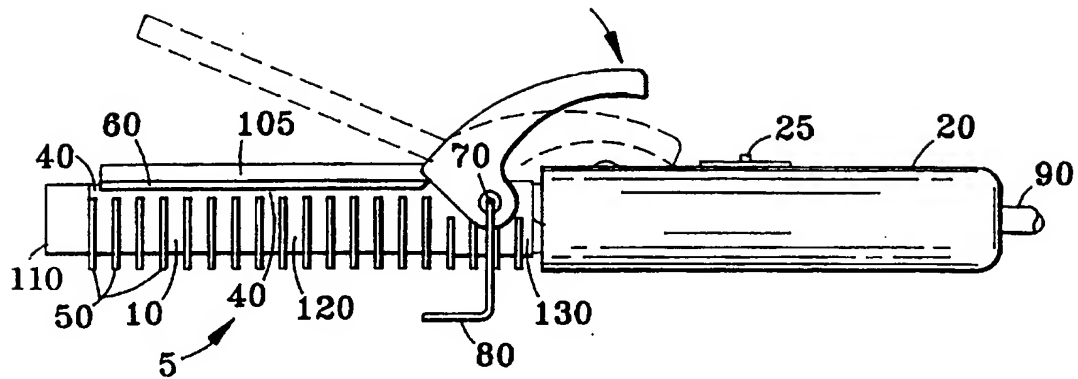


FIG. 1

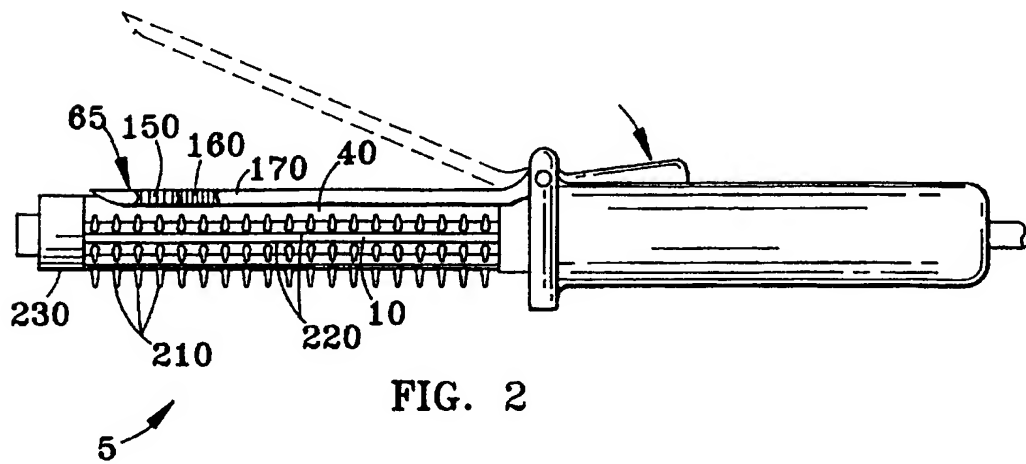


FIG. 2

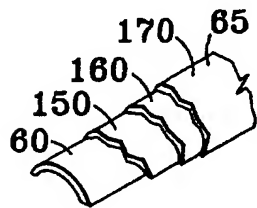


FIG. 2a

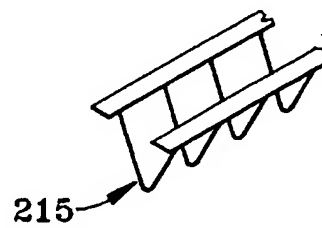


FIG. 2b

2/2

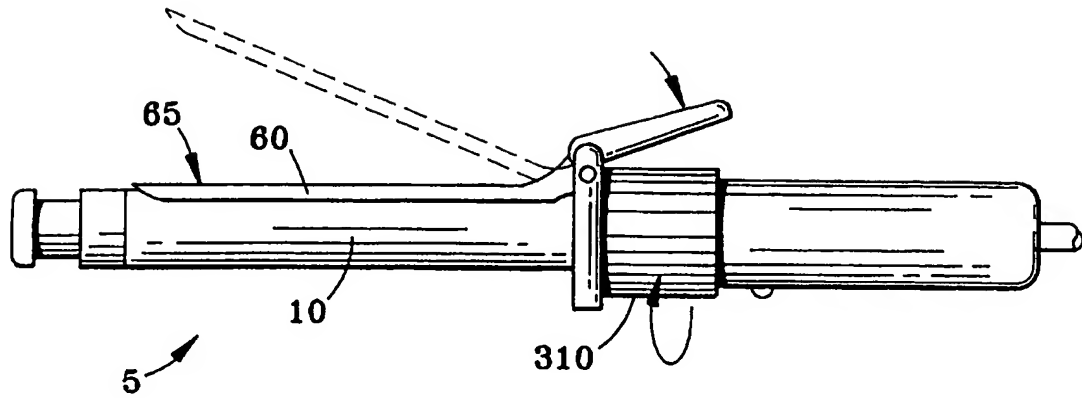


FIG. 3

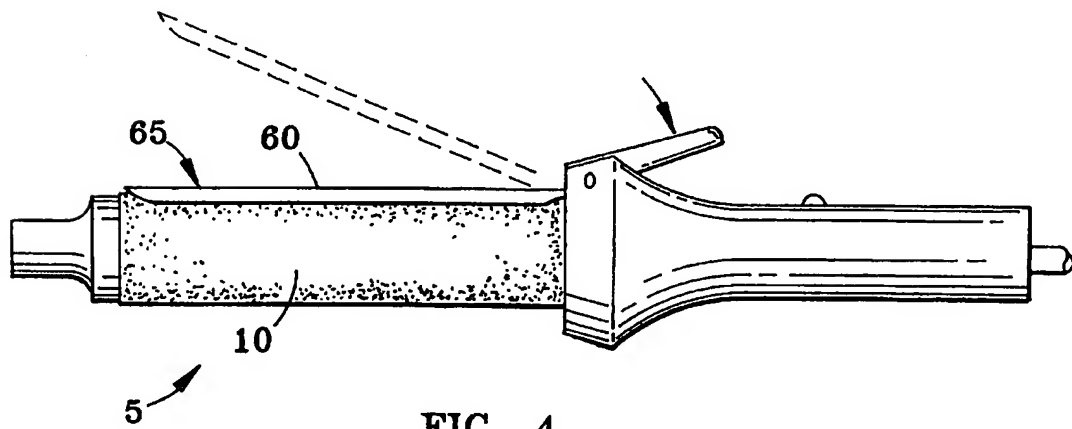


FIG. 4

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/13273

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>														
IPC(6) :A45D 1/04														
US CL :Please See Extra Sheet.														
According to International Patent Classification (IPC) or to both national classification and IPC														
<b>B. FIELDS SEARCHED</b>														
Minimum documentation searched (classification system followed by classification symbols)														
U.S. : Please See Extra Sheet.														
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched														
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)														
DERWENT WPI														
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>														
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.												
X	JP, A, 52-36078, 19 MARCH 1977, FIGS. 1, 4	1, 22, 23, 33, 34												
----		-----												
Y		3-21,24-32												
Y	SU, A, 512392, 02 JULY 1976, ABSTRACT AND TITLE	1-34												
Y	GB, A, 1 217 233, 31 DECEMBER 1970, PAGE 1, LINES 11-18	1-34												
Y	JP, A, 4-193201, 13 JULY 1992, ABSTRACT	1-34												
Y	DE 1 457 443, A, 20 FEBRUARY 1969, FIG. 4	1-34												
A	US 3665938 A (PEDERSEN) 30 MAY 1972	1-34												
A	EP 0 603 969 A (HAZAN ET AL), 29 JUNE 1994	1-34												
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.														
<table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"E" earlier document published on or after the international filing date</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"&amp;" document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family	"O" document referring to an oral disclosure, use, exhibition or other means		"P" document published prior to the international filing date but later than the priority date claimed	
* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention													
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone													
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art													
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family													
"O" document referring to an oral disclosure, use, exhibition or other means														
"P" document published prior to the international filing date but later than the priority date claimed														
Date of the actual completion of the international search		Date of mailing of the international search report												
25 NOVEMBER 1996		11 FEB 1997												
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231		Authorized officer												
Facsimile No. (703) 305-3230		JOHN A. JEFFERY												
		Telephone No. (703) 308-1782												

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/13273

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 294 136, A2 (THORN EMI PLC), 07 DECEMBER 1988	1-34
A, P	US 5,496,342, A (URICH), 05 MARCH 1996	1-34
A	US 3,877,411 (MACDONALD), 15 APRIL 1975, ENTIRE DOC.	1-34
Y	US 3,585,381 (HODSON ET AL), 15 JUNE 1971	1-3
Y	JP 57-59129, A, 09 APRIL 1982	1-3
Y	US 3,993,809 (SCHRANZ ET AL), 23 NOVEMBER 1976	1-3
Y	US 3,781,522, A (BOROM ET AL), 25 DECEMBER 1973	1-3
Y	US 3,576,761, A, (DAVIS) 27 APRIL 1971	1-3
A, P	US 5,499,597, A (KRONBERG), 19 MARCH 1996	1-34

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/13273

**A. CLASSIFICATION OF SUBJECT MATTER:**  
US CL :

219/225, 201; 132/232; 374/162

**B. FIELDS SEARCHED**

Minimum documentation searched  
Classification System: U.S.

219/225, 226, 222, 223, 227, 228, 201; 132/229-232, 269; 374/162; 116/216

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**

**THIS PAGE BLANK (USPTO)**